DEUTSCHE BUNDESBANK EUROSYSTEM

Estimating the effects of the APP at the country level

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*This presentation represents the authors' personal opinions and does not necessarily reflect the view of the Deutsche Bundesbank or of the Eurosystem

The Eurosystem's Quantitative Easing Programme

- On 22 January 2015 the Governing Council of the ECB announced the **Expanded Asset Purchase Programme** (APP).
  - Main component of APP was Public Sector Purchase Programme (PSPP) which consists of purchases of euro area government bonds, bonds issued by recognised agencies, international organisations and multilateral development banks located in the euro area.
- Evolution of APP:
  - January 2015: EAPP purchases of 60bn euros from March 2015 "at least until September 2016".
  - December 2015: announcement of purchases of 60bn euros "at least until March 2017…"; reinvestment of maturing securities.
  - March 2016: announcement of purchases of 80bn euros beginning in April 2016 "at least until March 2017 …".
  - January 2017: announcement of purchases of 60bn euros beginning in April 2017 "at least until December 2017 …"
  - October 2017: announcement of purchases of 30bn euros from January 2018 "at least until September 2018 … ".
  - June 2018: announcement of reduction in purchases to 15bn after September 2018 and stop of net purchases in January 2019.
  - Reactivation of APP in November 2019, net purchases of 20bn euros per month
  - …

Contribution

- Estimation of macroeconomic effects of APP has mostly focussed on the **euro area aggregate** level; little evidence on country-specific effects within euro area.
- We use a multi-country **Bayesian VAR model** with **identified unconventional monetary policy (UMP) shocks** to estimate the effects of the APP on output prices and bank lending in Germany, France, Italy and Spain:
  - identification via zero and sign restrictions; identification of UMP shocks via term structure of interest rates, e.g. Baumeister and Benati (2013), Kapetanios et al. (2012)
  - results are based on comparing model simulations with and without asset purchases using identified shocks;
  - simulations account (to some extent) for policy rate being fixed until the end of asset purchases.
- Methodological contributions:
  - identification of unconventional monetary policy shock relies on sign restrictions on euro area aggregates **or cross-country average** impulse responses,
  - statistical **test for cross-country differences** in the effects of the APP (Mandler, Scharnagl and Volz, 2016, 2022).

Results preview

- Quantitative results:
  - Across model specifications there is robust evidence for **positive** APP effects on **real output** and **bank lending to non-financial corporations** in all countries.
  - The **effects** of APP **on the HICP** appear to be **much weaker**.
- Output effects are smallest in **FR** with broadly similar effects in **DE**, **ES** and **IT**. Price level effects are largest in **ES** and smallest in **IT**.
- Positive effects of price level depend on identification assumptions:
  - positive output effects are robust to dropping sign restrictions on output and price level …
  - but price level/inflation effects drop towards zero.

Literature on country-specific effects of APP

- Estimation of macroeconomic effects of APP has mostly focussed on the **euro area aggregate** level,
  - Eg. Boeckx, Dossche and Peersman (VAR, IJCB 2017), Deutsche Bundesbank (DSGE, Monthly Report June 2016), Gambetti and Musso (TVP-VAR, 2017), Hutchinson and Smets (ECB projection, ManSchool, 2018), Lewis and Roth (BVAR, JFinStab 2019), Mouabbi and Sahuc (DSGE, JMCB, 2019), Rostagno et al. (VAR + term structure models, 2020), Sahuc (DSGE, EL 2016), Wieladek and Pascual (VAR, 2016), Rostagno et al. (2021).
- Other analyses investigate **spillover effects** of APP on countries not in the euro area.
  - eg. Jensen et al. (VAR, 2017), Varghese and Zhang (event study, 2018), Benecká et al. (GVAR, 2020)
- Little evidence on **country-specific effects** within euro area.
  - Wieladek and Pascual (VAR, 2016), Burriel and Galesi (GVAR, EER 2018)

Identification of asset purchase shocks in VAR models

Identification approaches for unconventional monetary policy (UMP) shocks used in the VAR literature:

- **Balance sheet shocks**: UMP shocks are identified as exogenous innovations in the size of the central banks' balance sheet (or of specific components), eg. Gambacorta, Hofmann and Peersman (country panel, JMCB, 2014), Boeckx, Dossche and Peersman (EA, IJCB, 2017).
- **Announcement shocks**: UMP shocks are identified as exogenous innovations in an announcement indicator (≈ cumulative announced purchases), Weale and Wieladek (US/UK, JME 2016), Wieladek and Pascual (EA, 2017).
- **Term structure shocks**: UMP shocks are identified as exogenous contractions in the term spread while the monetary policy rate remains constant, eg. Baumeister and Benati (US/UK, 2013), Kapetanios, Mumtaz and Theodoridis (UK, EJ, 2012).
- **External instruments**: construction of external instrument from changes in bond yields around releases of information about UMP, eg. Rogers, Scotti and Wright (US, 2016), Altavilla et al. (EA, JME, 2019), DeSantis and Zimic (EER, 2022).

➢ Problem: Difficulty in disentangling different unconventional monetary policy measures.

Estimation approach and data

- Bayesian VAR following the estimation approach of Giannone, Lenza and Primiceri (2015) with estimation of hyperparameters using “hyperpriors”.
- Estimation period: 1999Q1 – 2017Q4
- Euro area aggregate and four euro area countries: DE, ES, FR, IT
- Variables (euro area):

  EONIA, stock market index, nominal effective exchange rate, average 5y/10y government bond yields, CISS, excess bond premium, spread between euro area average and German 5y government bond yields

  Variables (countries):

  real GDP, HICP, 5y government bond yields, bank loans to non-financial corporations, MFI lending rate to non-financial corporations

  Variables (international):

  oil price, U.S. 5y treasury bonds yields

- All variables in log-levels, except for interest rates and CISS

Identification

Euro area block	UMP shock	CMP shock	Countries block (DE, ES, FR, IT)	UMP shock	CMP Shock
EONIA	0	-	RGDP	+ (avg)	+ (avg)
NEER	-		HICP	+ (avg)	+ (avg)
stock prices	+		5y govt. bond yield	-	-
5y/10y govt. Bond	-	-	bank loans to NFCs		
excess bond premium	-		Lending rate		
CISS	-				
spread EA-DE	-				

Zero and sign restrictions on impulse responses; UMP: unconventional monetary policy, CMP: conventional monetary policy, sign restrictions imposed on impact, no restrictions on international block (oil prices, U.S. bond yields); algorithm by Arias, Rubio-Ramírez and Waggoner (2014) .

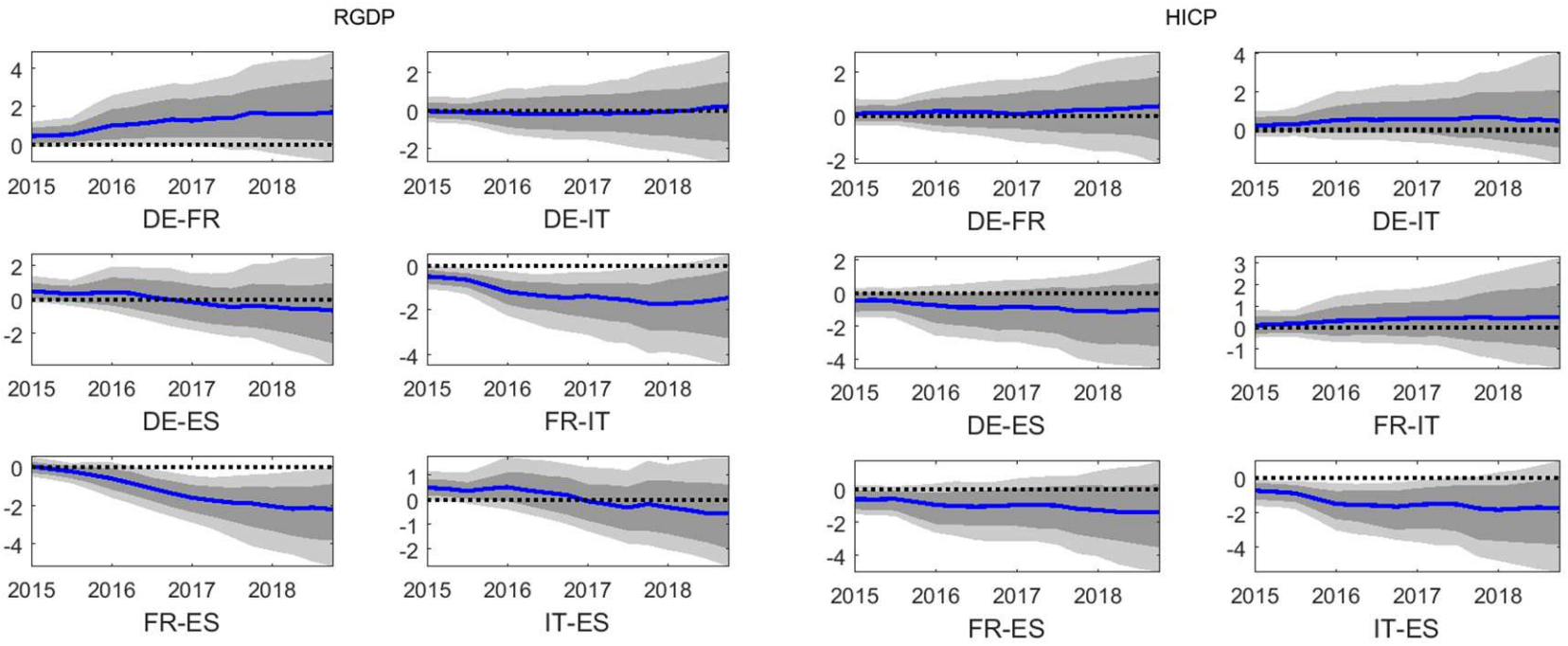
Simulation setup for estimating APP effects

- Scenario analysis as **VAR forecasts**.
- **No-APP scenario**: **unconditional forecast** using each draw of the VAR model starting in 2015Q1 until 2018Q4.
- **APP scenario**:
  - Simulate for each draw of the VAR **identified temporary UMP shocks** of -60bp (2015Q1), -20bp (2015Q4), -30bp (2016Q1), +10bp (2017Q1), -20 (2107Q4), 0bp (2018Q2). (Shocks are based on revisions in technical assumptions of Eurosystem Projection (BMPE) and Altavilla, Carboni and Motto (2015).)
  - Force **policy rate to remain at path from unconditional forecast** (for a given draw of the VAR) by using conventional monetary policy shocks.
    - **Conventional MP shocks are unanticipated**; anticipation of fixed policy rate over APP horizon will lead to larger expansionary effect in models that explicitly account for forward-looking expectations; thus, we are likely to underestimate APP effect through this channel
- **APP effects** as difference between APP and no-APP scenarios.
- Eliminate draws which overfit policy rate and imply explosive behaviour of simulation.

Heterogeneous effects of asset purchases?

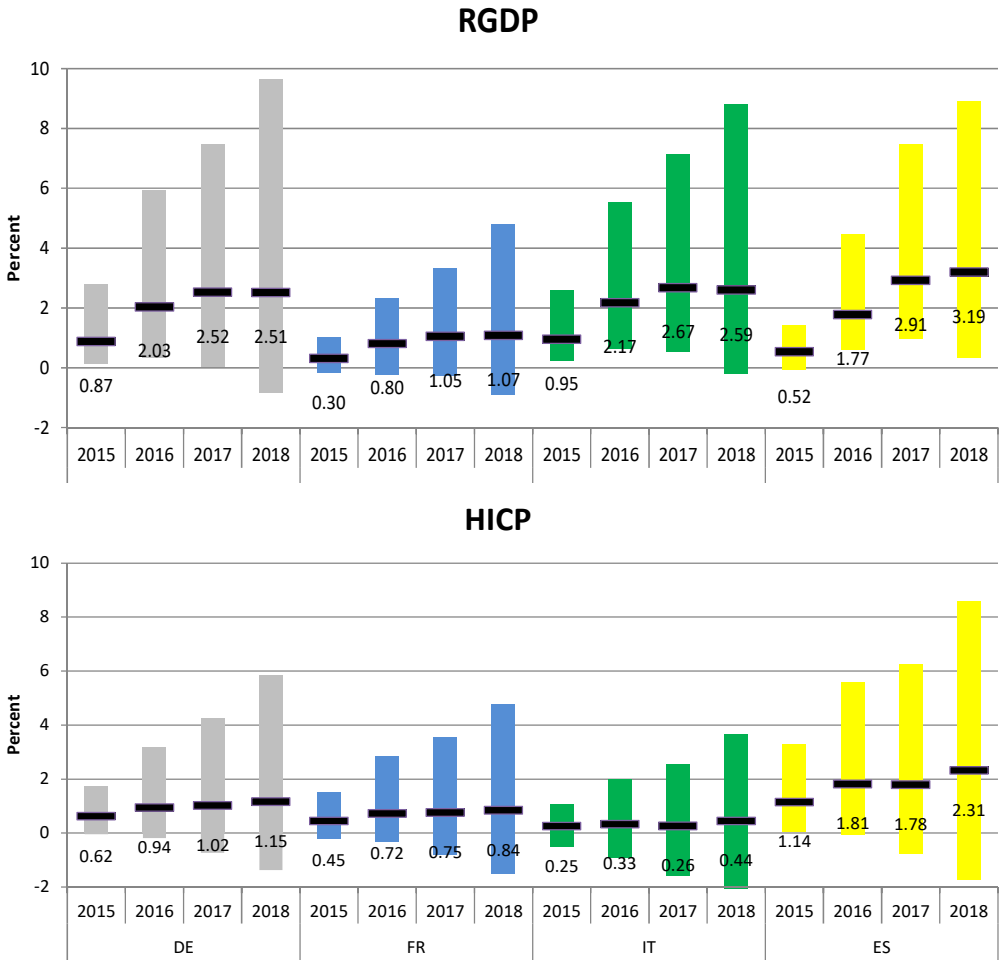
- Statistical theory does not provide for rigorous test in differences in impulse responses (approximations as eg. in Schenker and Gentleman, 2003).
- Approach follows Mandler, Scharnagl and Volz (2016, 2022):
  - ➢ Bayesian estimation + multi-country structure allows for assessing cross-country differences in impulse responses in a statistically rigorous way as the multi-country structure accounts for the cross-country correlation in the parameter estimates.
- Here, application to cross-country differences in APP effects:
  - For **each draw** of the VAR, compute the **pairwise difference** in the simulated effects of the asset purchase programme.
  - Over all draws the distributions of these differences approximate the posterior density of the cross-country differences in the APP effects.

Heterogeneous effects of asset purchases?



Cross-country differences between simulated APP effects from MC model (cumulative effects, percentage points, median, 25th, 33th, 66th and 75th percentiles)

Results – cumulative effects within each country



100 times log-difference between conditional and unconditional forecast, average per year. Black lines and numbers indicate median estimate. Bars represent area between 16th and 84th percentiles.

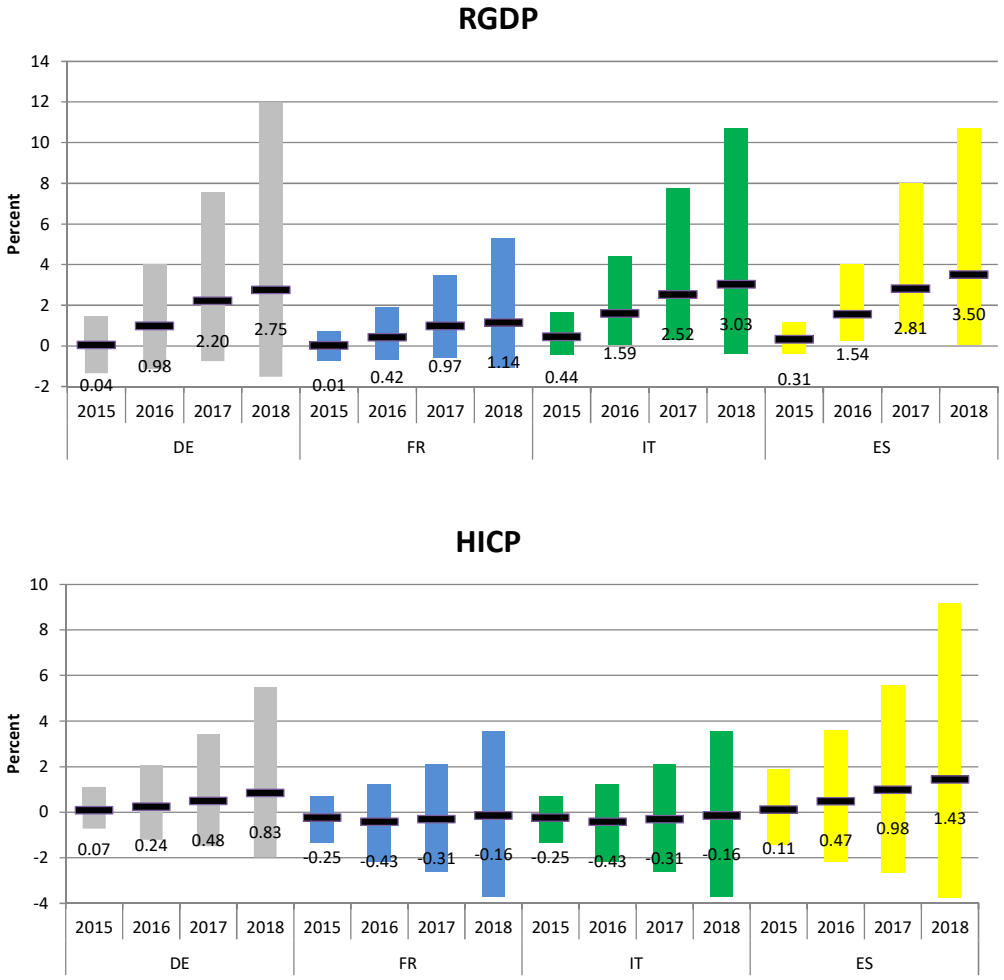
Wider applications of comparison approach

- Can be applied to any VAR model which analyses the effects of a **common shock** on **different entities** or **variables**,
  - ➢ e.g. heterogeneous effects across countries, regions, sectors, …
- Substantially increasing the number of entities or of variables per entity would benefit from an estimation approach that imposes additional assumptions for reduction of estimation uncertainty, e.g. Global VAR, panel or factor structure.
- Comparison can be made for any object that can be constructed from the VAR coefficients, e.g. impulse responses, forecasts, simulations, scenarios, …
- **Previous applications** to comparison of effects of conventional monetary policy and forward guidance across euro area countries.

Robustness tests

- Use GDP deflator in place of HICP.
- Include **euro area real GDP and HICP** and place sign restrictions on euro area aggregate output and price level instead of on country averages (MCEA model).
- **Drop sign restrictions** for UMP shock on average **output and price level responses.**

Results –no sign restriction for UMP shock on output and price level - cumulative effects



100 times log-difference between conditional and unconditional forecast, average per year. Black lines and numbers indicate median estimate. Bars represent area between 16th and 84th percentiles.

Summary of results

- Model simulations strongly suggest **positive effects on output and bank lending to NFCs** in all countries.
- Effects on **HICP** are estimated to be much weaker, ie expansionary output effects seem to translate into consumer price inflation only to a limited extent.
- Output effects are smallest in **FR** with broadly similar effects in **DE**, **ES** and **IT**. Price level effects are largest in **ES** and smallest in **IT**.
- More robust evidence for positive effects on output (and bank lending) than on price level.

Supplementary material

Econometric approach

Estimation approach follows Giannone, Lenza, and Primiceri (2015)

- Bayesian VAR with Minnesota-type prior,
- hyperparameter selection using a hierarchical specification:

$$p(\Gamma, \Sigma, \gamma) = p(\Gamma | \Sigma, \gamma) p(\Sigma | \gamma) p(\gamma),$$

with Γ: reduced form VAR coefficients, Σ: reduced form covariance matrix, γ: hyperparameters, $p(\gamma)$: hyperprior

- Conditional on the hyperparameters the BVAR retains the normal-inverse-Wishart prior.
  - As a consequence, the joint posterior of Γ and Σ conditional on γ is also normal-inverse Wishart.

Econometric approach (cont.)

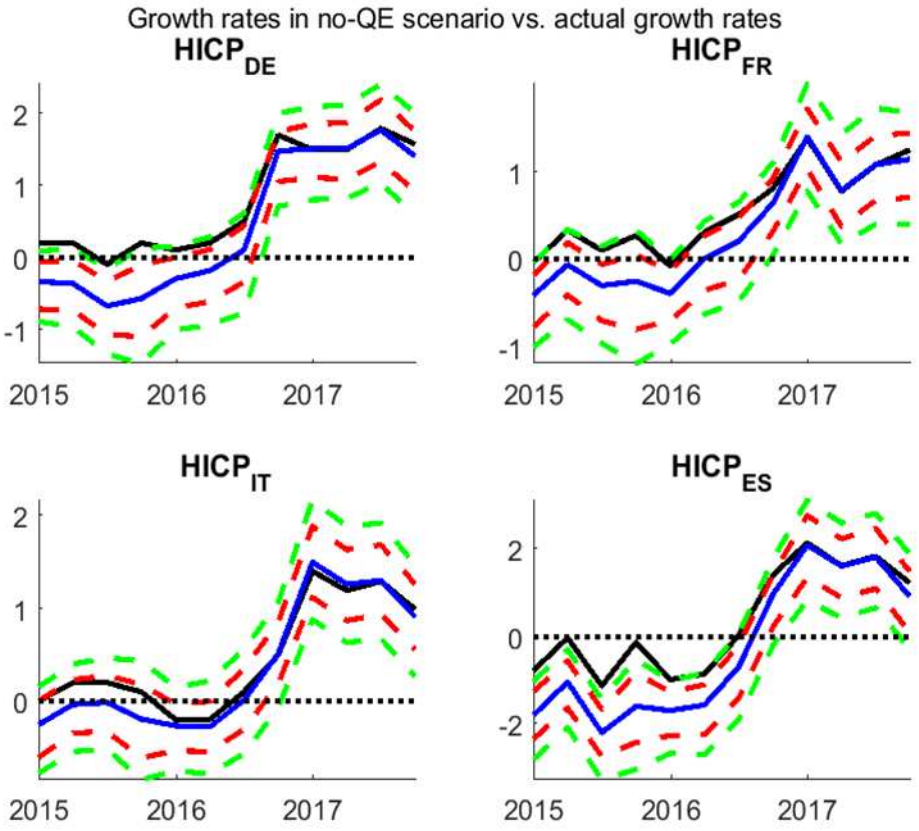
- Giannone et al. (2015) show that draws from the (marginal) posterior of γ

$$p(\gamma|y) \propto p(y|\gamma)p(\gamma)$$

can be obtained using an analytical expression for the marginal likelihood $p(y|\gamma)$ which allows to generate draws from the posterior of γ using the Metropolis-Hastings algorithm.

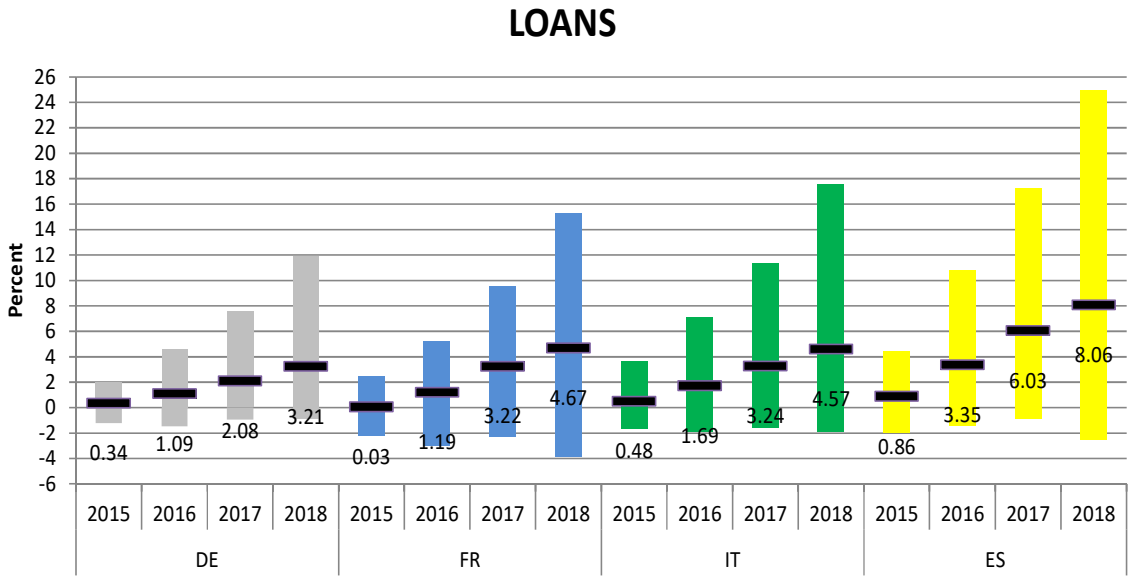
➢ Thus, the MCMC algorithm combines a Gibbs sampler for the VAR coefficients and (co-)variances with a Metropolis-Hastings step for drawing the hyperparameters.

Results – inflation rates without APP



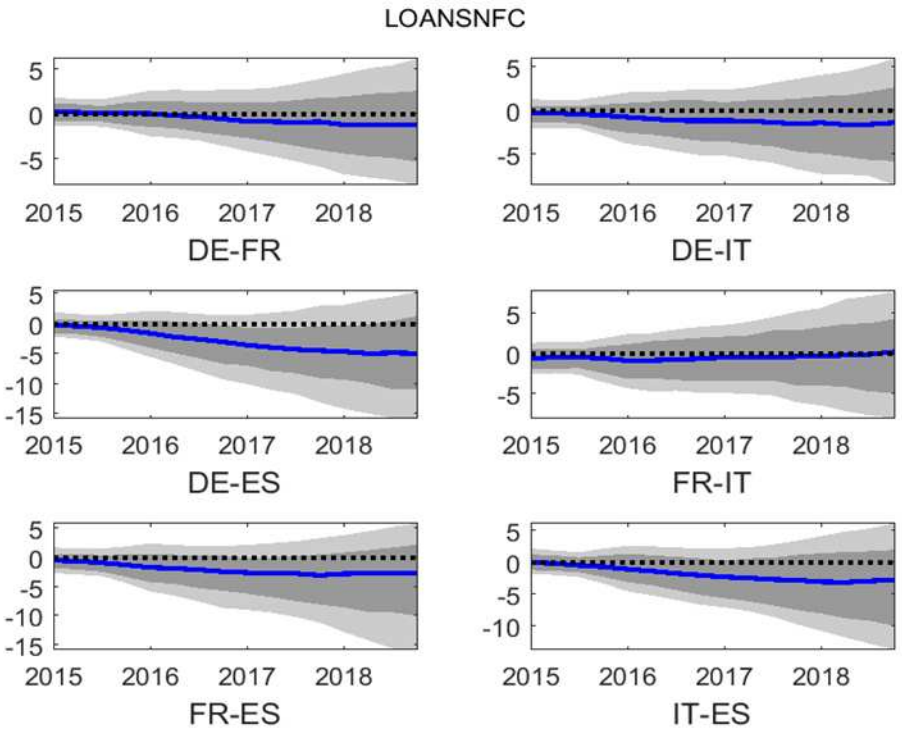
Actual (black) and counterfactual inflation rate without APP, median of counterfactual in blue, 33- and 66% percentiles in red, 25- and 75% percentiles in green.

Results –cumulative effects



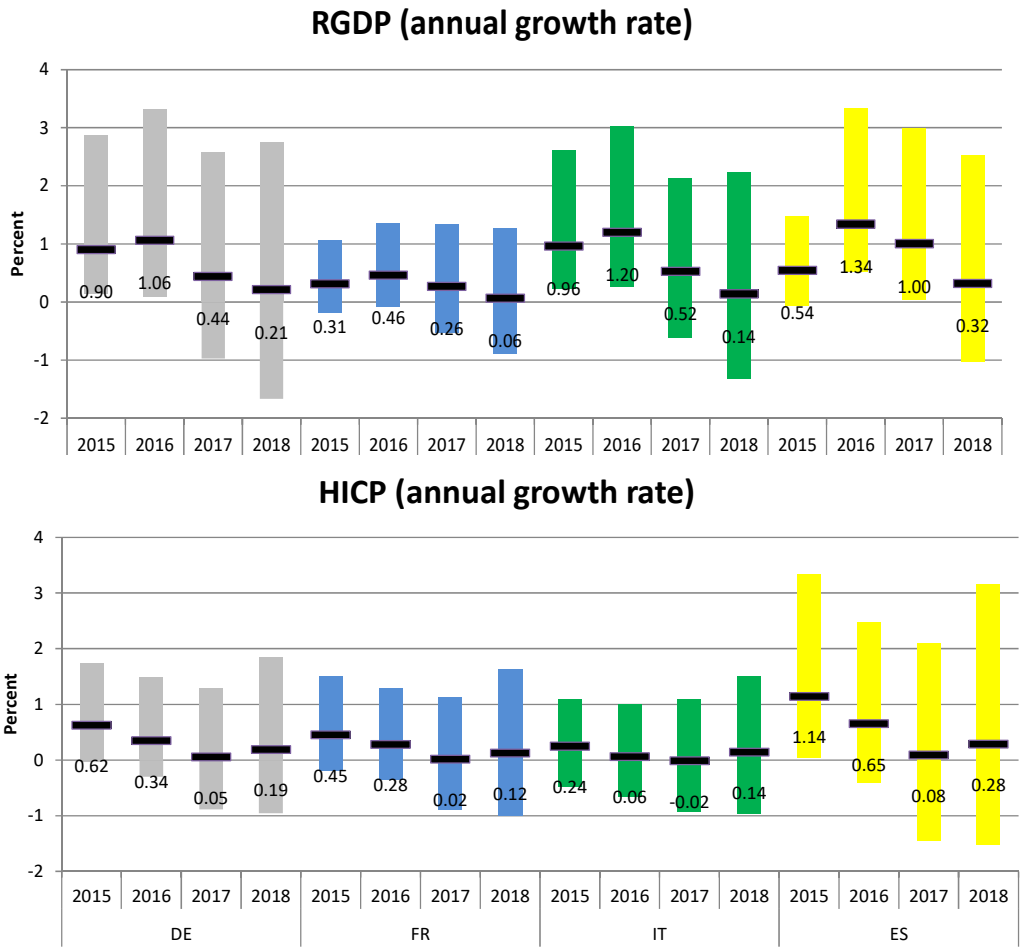
Deviation from annual growth rates from unconditional forecast (annual averages). Black lines and numbers indicate median estimate. Bars represent area between 16th and 84th percentiles.

Heterogeneous effects of asset purchases?



Cross-country differences between simulated APP effects from MC model (cumulative effects, percentage points, median, 25th, 33th, 66th and 75th percentiles)

Results – growth rates



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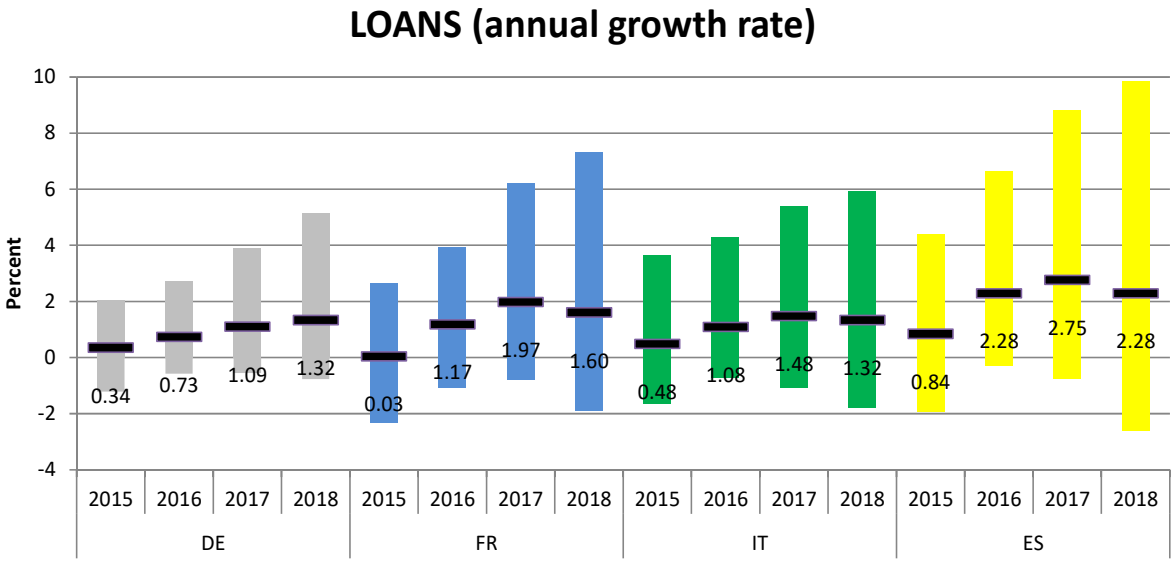
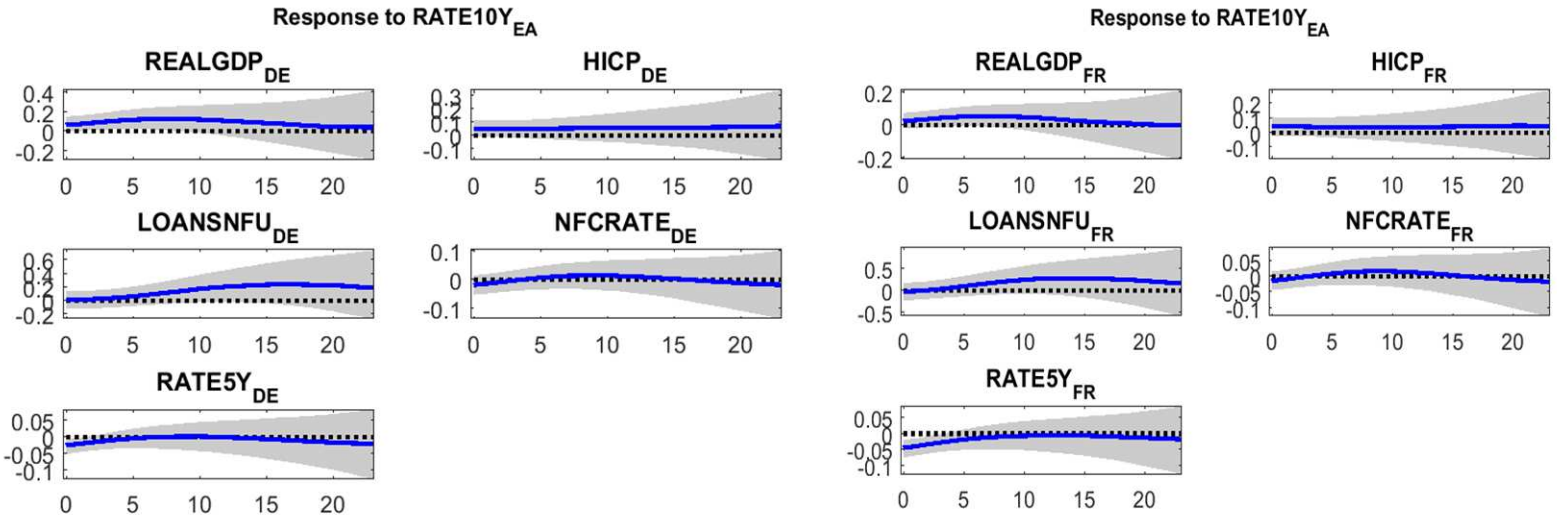
Results – growth rates

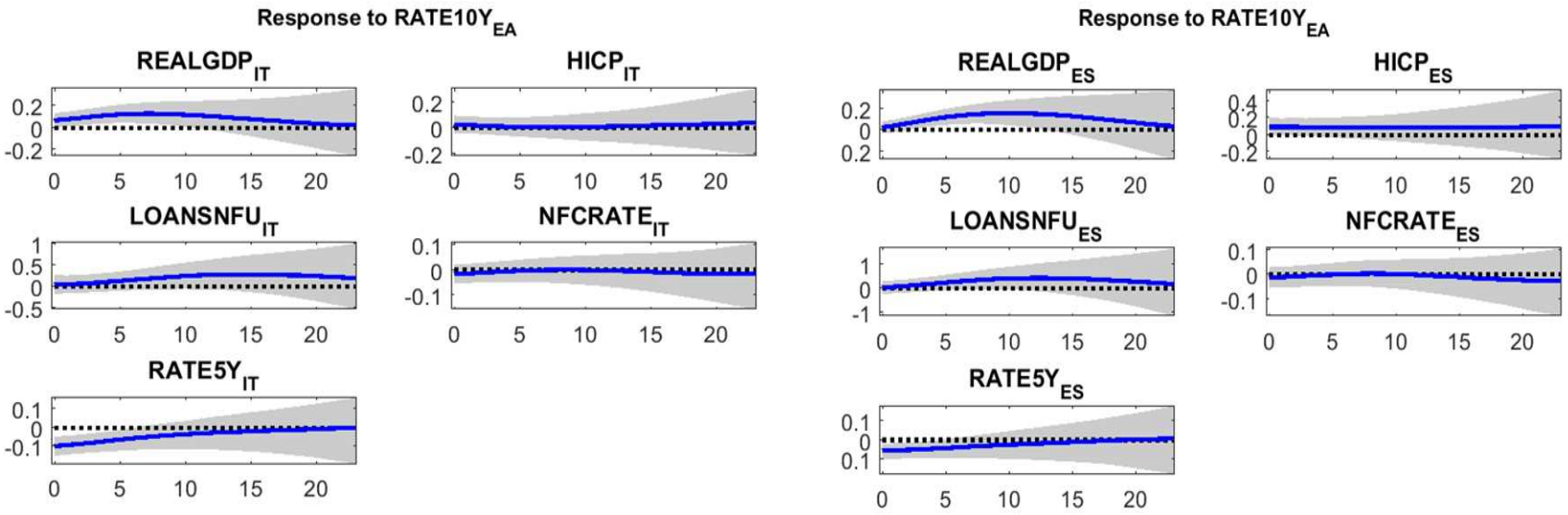


Deviation from annual growth rates from unconditional forecast (annual averages). Black lines and numbers indicate median estimate. Bars represent area between 16th and 84th percentiles.

Impulse response to UMP shock – baseline model



Impulse response to UMP shock – baseline model



Impulse response to UMP shock – baseline model